Group Interview 6

VR: So I'd like to ask you again about the misconceptions that are still floating around about the continuum.

WM: Well let me take a shot at it just because it's a reiteration of something that I said earlier. I thought a couple of key areas are that . . . One, a lot of people continue to think of this as a zonation thing. They don't pick up on the implications in the term "continuum". The gradual, progressive changes that take place. So you don't expect real sharp changes. You expect real gradations in these changes. But we had to illustrate it—we felt we did anyway—in the original river continuum by breaking it into points and rather than talking about every infinitesimal point along that line, we took two or three or four key areas and described those in detail. So I think people have misconstrued that into thinking, "Oh, those are zones." And those are in the classic European sense rather than in this whole new paradigm of gradual progressive changes. A second is the assumption that we thought that all streams started in deciduous forests, and we didn't. We considered that very much in detail, in part because I was coming from a desert biome, and I had another perspective of the whole distive system. But again, to avoid confusion, we started with what we knew the best. We'd all worked in deciduous forest streams, and we could describe those in some detail, and so we worked with that. But the overarching issues are, "What are the drivers" Whether it's allocthonous detritus or whether it's sunlight. And then depending on the proportion of those along the system, that's the way it plays out within the system. And I think that's been missed by a lot of people as well, and we tried to correct that with the subsequent publication. Another is the pristine nature of the model. In essence, for the modern system, we were erecting a null hypothesis against which you'd test these things and say, "Well this varies." And then we say, "Well, what's the reference point? What does it vary from?" It varies from this model that we set up and which we tested and basically conceptualized from the standpoint of a pristine system. And then ultimately emerging later as we got into this were other issues. As we had the data and the insight, we could say, "Well, look. There's more impact from tributaries than we'd originally anticipated. There's more impact from local geomorphology than we'd normally anticipated." And all those things could easily be put into that broad template once we had this model that was the river continuum.

2:55

VR: Thank you. Anybody else have any—

BC: I'd like to emphasize the one point he talked about. There is a model starting in the deciduous forest. Cause again, that's what we knew best. But to this day—and I probably milked this as much as anybody giving all these talks to trout clubs and things now—you really have to emphasize that the original model wasn't built on the streams, like in Yellowstone we're going to go out and sample when I teach up there. Things like this. The model wasn't—People still take wherever they are and try to cram their model into it, without realizing these historical perspectives

3:38

RV: I don't let this deciduous or coniferous forest bother me one bit. It provides inputs. And that's what we were dealing with. We were dealing with a partitioning of the forest as the stream enlarging from the inputs of tributaries or groundwater along its reach. So I just don't understand this hang-up on it was developed in Eastern deciduous forests. We had the data from there, from Eastern deciduous forests. That's where we lived. That's where we worked. But it's not the significant issue. This concept was designed and applies mostly to eastern deciduous forests, when in fact it doesn't matter. The rate at which the stream partitions and lets light in. That may function by the type of forest it's in, whether it's constricted in a canyon. Those are factors, too. But how wide the flood plains are. These are differences in topography. They can all be accommodated. So many of these side issues are just shoved at the back of somebody looking ahead at a new design, a new framework.

5:03

BC: The point is, we recognized this. We even made trajectories that said P/R ratios is this—

RV: So I let that stuff run off. And I think that some of the more interesting aspects of the research that we put forth for people to look at and evaluate was that stream communities are structured by local inputs and what's transported downstream. And what's very interesting, at least to me, is that the communities that are structured in these reaches along this continuum exploit these two resources, and the inefficiencies are the transport downstream, so that when you look at a progression of these communities' structure along the continuum, it becomes a more efficient-looking system. And it gives a terrific framework for pollution ecologists to look at holes in this community structure and leakage. So here's something that's out there for everybody.

6:22

JS: Yeah. It's a world view. The power of the river continuum, in my mind, is a heuristic device. Something that you can talk to people about. How you might think a stream would operate that they can understand. And what has amazed me in looking at papers since is the literalness of scientists, of taking a little piece of a point in it, when in fact to me, the reason it probably gets continually cited is it's a good story. It's a world view. It's a stab at taking all the little reach stuff, all the little rock stuff, its own portion, and talking about this progression of small to large. And I don't think we had that kind of framework. And we're still struggling. We've done very elegantly in taking parts of big rivers and flood plain rivers and progressed that way. But for an overall, looking at little streams to big streams, I haven't seen as interesting an explanation and as easily talked to students about as what that was.

7:36

WM: I think one of our innovations was that however this template changes, the biota will respond, and that response is predictable. And that's really the key. If you mix it up and change the template, then you ought to expect some sort of biotic response and that ought to be able to be described and predicted ahead of time.

7:57

KC: You know I think the current attempt, I won't say discredit the continuum, but to dissect it, is that the pattern that's really out there is the pattern of the discontinuities, not the longitudinal transport. And Lee Benda is on this. And that's a strictly geomorphic argument at the moment. There's basically no biology whatsoever to support that. And they're looking for it. And that's fine. But this is the kind of thing that happens. Perhaps the people that objected to it most violently for whatever reason, have spun off into a whole bunch of new experiments and things. I mean, that can't do anything but help.

8:37

WM: But again, the geomorphic argument is one of hot-spots. Whether landslides come in, or whether you have floodplain openings and side channels, or tributaries that came in and you get a very complex channel, and set of channels. And it's real. I mean, there's no question it's real. But you don't hang a river system on the nodes. I mean, they're an important part of it, and in fact what we were dealing with was that whole continuum transportation.

JS: In fact I've argued that it's a different scale. We were looking at a different scale. And scalar differences are really important in terms of what you see and what are the drivers. So the local tributary scale is a lot different than the whole watershed, the whole basin scale that we were viewing.

9:34

BC: But how would we argue with government that biology doesn't track the geomorphology. We never—there was a whole idea. And so yeah, if these are geomorphic hotspots from a geomorphic perspective, does the biology track that. I think there are some overriding things that kind of smooth that out for the bigger picture.

10:05

RV: You've really got to hark back to the fact that streams exist for two reasons: to transport water and sediment. And the biology has to fit in. And the sediment delivery changes because of loss of vegetative control, there are going to be changes and the biology will shift. So I don't know where all the arguments are coming from, but they're healthy.

JS: And again, I think that you're talking about trying to redefine a new world view. And I really think that to me that's what I look at, is we took a shot at a world view. And it hit. Why would everyone bother going back to it either to dissect it or to apply it It was a world view. And we'd expect some other group of people to refine a world view and come up with something in the future.

11:11

JS: And in the competition for funding, you don't get funding for redoing the same old thing. You have to have a catchy name and a supposedly new concept.

KC: One thing Jim mentioned that reminded me of something is that there's no fish story in here. I mean, we didn't spend—at sites, at our own sites . . . But there's really no fish story. And I think that's kind of unique, because a lot of these things, in Europe especially, have been driven by the fish story. "Here's a fish story, and now we'll try to fit anything to the fish story."

RV: We entertained the fish story. I think we wanted a fish story, but we couldn't hook Jim Hall.

JS: He looked at the immensity of the task, particularly where we got to the large river, and he said, whoa.

KC: But we didn't do a lot of fish measurement for the continuum. Bert and I did a lot, but that was very few species.

RV: A detailed study of the fish population would have been comparable to trying to do something with the benthic community and a production estimate capacity, and that would have been an expensive project on its own. So unfortunately the fish and the benthic productivity had to be sacrificed in this study.

12:31

KC: There're no species of fish out here compared to the East anyway, except we got them in by…

WM: Well and the Salmon, operationally, we were constrained with the fact that we were going with a system that had threatened salmon in it. And Fish and Game was not keen on issuing collecting permits. That even got worse as—

VR: He's interested in the ocean, not . . .

KC: But since fish drive so many studies around the nation, people are trying to see how they'd link into the . . .

13:04

VR: In a way, it's amazing you got so much money without doing fish.

KC: Well we got it from very non-fishy people.

JS: Actually, at the time, the National Science Foundation, unless you were Don Hall's Ponds, they weren't as keen on fish as a model to get at the ecological stuff. And some of it I think was on the heels of the IBP where they were more into trophics and energetics and the nutrient cycle. They seemed to be the hot—and there were technologies, certainly with the isotopes, that were breaking out of the national labs and use

WM: So there's a current paper, recently published, by Kurt Fausch and a number of co-authors that directly gets at some of these issues, and expands to really emphasize the fish work and the linkages and to look at the system in terms of networking as opposed to the linear model that we worked with, in part as explained earlier, because of financial constraints.

14:10

VR: What I'd like to do is let's go around the room and ask of the tens of papers that were produced directly from the river continuum work, which one do you think, personally, is the one that is your favorite or has the most telling message about the overall project. Jim, can we start with you

JS: Oh, the first one. No question about it. It was the story.

VR: The 1980 paper, Canadian Journal of Aquatic Science.

JS: And so, that's one I go back to. The others give some life to it. The monograph paper and all are really the hard numbers behind it. Then, I don't know all these thirty-three papers. I don't remember them all. But those were real important. And in fact I think the monograph paper was—

VR: The 1983.

JS: Yeah. To me the 1983, the inter-biome one, really set it. And I remember those much more than the ones we did at our site. I mean the sites were interesting. But that wasn't—to me, if I had to give people something, I'd give them those two papers.

15:35

VR: Bert, what do you think

BC: I can't argue with that. The inter-biome paper, after the first one. The first one set the stage for all the others.

WM: The first paper gave us the framework. The inter-biome gave us the meat; the flesh onto the frame.

VR: Robin, do you agree?

RV: Yeah, I certainly agree. And I think the cross-biome paper is the important meat to pull it all together, and I think Tom's primary production paper was a very good—

VR: That was in the . . .

BC: The one that summarized the . . .

WM: Basically inter-biome metabolism comparisons.

RV: So I think we had three major . . . Ken, Wayne?

WM: Well, first of all, those set well above, so I fully agree. I think for me, the most fun, in a way, and the one that was very important, was the Recent Advances in Stream Ecosystem Dynamics, where we were able to sort of add our additional modifications. The insights we gained. And it was intended as an answer to some of the critics. The Winterbourne and Rounick paper, and to the Statzner and Higler paper. So this was kind of a chance to catch your breath and say, "Look, you guys are really taking this in a wrong light. Plus, we recognize that there's these additional things that need to be cleaned up. The sliding scale idea, the tributary effects of the Sansaw So that one I would add as another one that I—

VR: This is in the Fontaine and Bartell's book?

WM: No, no. This is Canadian Journal. The second paper in Canadian Journal of Aquatic sciences.

17:20

KC: I'd agree entirely with the three that came out. The first one, clearly, and the inter-biome was—Putting that together was where I felt we really understood something about how well the story actually worked. And then Tom's work with comparing the—and the chamber technology was so important. And measuring primary production, the PR ratio measurements in the field were so important. To summarize that on an inter-biome basis was really terrific, I thought. I enjoyed a lot, I don't know if you could get a number, the organic budget paper we did? Now that was a lot of fun. Stu Fisher was involved in that one.

VR: Where did that appear?

WM: In the book. In the stream-dynamics Barnes and—

KC: Oh it is? Okay, it is. Yeah, that's right. It's in that book. Bout the only place we could . . . And that was a lot of fun, because we talked a lot about scale. Full scales, and capture of flood plains, and all that kind of stuff, and we went around a lot with Stu, 'cause we were trying to match up these budget papers that had been done every place, and they didn't match worth diddle. And trying to make sense of that. When we all sat around with Richey and tried to figure out where the organics were coming from in the Amazon, the lower Amazon, and everyone said, "Well it's all the floodplain story." And so we did the numbers, the best numbers they had, and it didn't account for a major portion of the organics.

18:55

JS: This was at a meeting where on the back of an envelope we were estimating the transport of carbon from the rivers of the world into the ocean. And we had Tom John and Ritchie so we were using big numbers. And then, the amazing thing about dissolved organic carbon, as opposed to the particulates, is that the range is pretty damn narrow. I mean, what, a couple to a half or something. So you could then get away with just multiplying a single one by something.

19:30

KC: But then Ellis said whole damn islands are coming down as—

JS: Right, but the tributaries were huge, and . . .

KC: Yeah, they could not escape the fact that the upstream delivery was important. They tried hard to say it's just this kind of story, but it just doesn't wash.

WM: I'd add maybe one other paper that for me was perhaps the hardest one to do, and yet probably equal in importance to the inter-biome comparison paper. And that was the eighth order Salmon paper, because that really brought together the second part of our proposal. And it's a major publication effort in that regard.

VR: And that appeared in?

WM: Oh, where did it appear? I'm not sure. It was such a relief to get rid of it, I can't remember where we went.

BC: I see it with a blue cover. And that's ecology or ecological monograms.

WM: At any rate, it took a lot of time just because the funding had ended, and a lot of interest of the other PI's and so on were going other directions, and that just drug out over a number of different Christmas breaks, where I and Bob Petersen spent a lot of time—

BC: You can see the care with which we selected the journals to submit our papers. We have no clue. How fast will it come out? How quickly we get a review?

21:09

VR: Well I'd just like to ask you if you have any last comments. What to you if you have a comment that can encapsulate the idea of the river continuum or your ideas about it, what's a closing message that you'd just like to leave? Robin, do you have a . . .

RV: I think that it's really exciting that a group of people could get together, flush out an idea, design some experiments and hypotheses to test, and get an interesting job done. It was diverse people, and Wayne did just a terrific amount of work, and he was—he was a general.

KC: You know, I think about my dad, just before he died, sorta said, in context of all the fishing he'd done, said, "I had a hell of a run." We had a hell of a run. We really did, you know? It was just great.

JS: Well I guess—yeah. Cause I came from a liberal arts background. I was a philosophy/ political science major. And then came and got influenced in biology and got a masters degree in biology. And to me it was always just data collecting. And that was pretty boring to me. Really is. And here was a place where you could see that science was about creativity, and about creating this story or world view. And that was just was a total turn-on. An adrenaline rush of trying to see what it was and then figuring how you could measure it. Even though I didn't like to measure it. But at least I had a framework. I had a story that was fun and it was exciting and it was evolving. You needed new technologies to get into it. You had a great group of people to interact with. And again, you learned a whole bunch about interacting with people. The good, the bad, and the ugly.

BC: I might make a couple observations I got out with. First, to me, it largely put to rest this idea of trying to classify rivers, and the businesses of zonation and all this stuff. That it showed the downstream linkages. And the other thing that surprised me, in a way, was how quickly the concept was not only accepted, but criticized. And a hypothesis is for long-term testing. But it didn't take long to get some critics out of the woodwork. And this surprised me a little bit.

RV: Instantly.

BC: Yeah, instantly.

VR: Which probably said it was a good idea.

WM: I would just add that I think that's the way science is supposed to work. And sometimes we get a little thin-skinned about it. But basically skepticism is healthy.

BC: Sure it is. That's what a hypothesis is for.

JS: That's what we do best, is falsify. That's the only thing with certainty we can do.

24:24

VR: Wayne, do you have any final thoughts?

WM: No, I—well, of course I do. And some I'll try and restate here. One observation that kind of goes along with what Robin was saying, that I kind of had this conception that to do research, it sort of had to hurt. You just really had to work yourself to the bone, and you had to be really narrow and stringent about it. And Robin comments to me at one point, that if we're going to do research, it ought to be fun. And I think that these people have just reflected in their comments that it had been fun. And the fun, sometimes, is really hard work anyway, but it's the intellectual stimulation that gives us fun, and the sparks and the overall reason for wanting to go on. And then the ability to actually do something about that; to test those things and to bring a whole bunch of other great people together. It's not just the PI's. It's this whole sort of army of folks that contributed. Those are the lasting things that we have. And overall, I've been gratified. And I think that the model that we've evolved, and that we've put forth has held to the test of time and have changed the direction of science in stream ecology profoundly and in a very positive way. I think we're better off and just as excited now as we had been twenty-five, thirty years ago.

RV: I think a little add-on to that is that there were so many people who helped us. So many young people that helped us. And I think just seeing their growth and going on into science and things that they're doing. I think it's very rewarding. I take a lot of pleasure in seeing the science that young people are doing that worked with us. And that's sort of a continuation of your life into something else. I think a second aspect of our inter-personal is that we really made good friends of one another. I mean I just love to go visit with Jim and hack around the woods, travel with Fred Swanson in the woods and rolling rocks, and discussing landscapes. Continues today as a pleasure. Going to Wayne's and hiking around in the parks and landscapes with Wayne. It's just a continuation of friendship that's wonderful.

27:07

KC: It's sad that Bob Peterson ended so soon. He died way too soon, and so some of these tendrils we've sent out got chopped off way too soon. But yeah, Robin's right. We became good friends. It's really fun. So still, Robin and Wayne have been hacking around in the forest fires. And it was great.

WM: Yeah, so I mean, this is fun, what I do. So this is. But what a great thing to get back together again, and kind of have this opportunity.

BC: And there're some aspects that we didn't cover, like visiting Wayne, and getting put up in a trailer sleeping over a skunk. Some of these things, you know, they were still great.

WM: Well since you didn't bring it up, I won't say what I was thinking about that.

VR: Well let me say one last thing. From the time this idea started, all you kept on asking me, "Why are you doing this?" And I think I can sum it up best by telling you, when I finished graduate school and started thirty-two years ago, the five of you were the film stars. You were the celebrities. And my entire career, I've seen the influence that this has had in terms of putting people down paths that really sidelined them because they got caught in the details, or of just turning people on to the way rivers work. And the reason that I wanted to do this is I think this is the great story in aquatic ecology for the twentieth century. And I really wanted you guys to be able to tell it. I have to say this has been one of the best two days I've had in my life in terms of just stimulation. And let's end with a big thank you to the five of you. Okay. The film stars. That's the only term I could use!